

U.S. PATENT APPLICATION

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Invention: MOLD PART GUIDE MECHANISM

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SPECIFICATION

MOLD PART GUIDE MECHANISM

BACKGROUND OF THE INVENTION

1. Field of the Invention

5 The present invention generally relates to multipiece molds, and specifically relates to guide mechanisms for ensuring precise placement of mold parts when in the mold forming position.

2. Brief Discussion of the Prior Art

10 Multipiece molds for forming molded products, and in particular injection blow molded products, are well known. Generally, a parison comprising the material to be molded and located on the end of a blow molding tube is inserted into position in a lower mold half. The upper mold half is lowered into the mold forming position and high pressure air and/or movement of the air tube results in the parison being expanded into all portions of the mold. After suitable cooling, the mold halves are separated and the blow molded product removed.

15 In many blow molded products, there are recessed bottoms on the molded product which make it difficult, if not impossible, to separate the mold halves without damage to the molded part. In such molds, it is generally acceptable to utilize a third mold part identified as a bottom end plug. This plug is slid into the mold forming position and, after the blow molding is complete, can be retracted so that any protrusion on the end plug (used to form the inner curvature to the bottom of the product) does not obstruct removal of or otherwise damage the product from the upper and lower mold portions.

20 In order to form a properly molded article, it is necessary that the edges of each of the mold portions fit precisely. Wear between mold parts would result in undesirable part lines being formed on the moulded product. Generally, the upper and lower mold halves are moved on bearinged and lubricated posts relative to one another, thereby maintaining a high degree of tolerance with respect to these mold halves and the direct and non-sliding contact between the upper and lower mold halves accounts for the general absence of wear.

However, where a bottom end plug is required, the plug is slid into and out of the mold forming position, and thus there can be sliding contact with one or both of the mold halves.

Positioning of the end plug is generally accomplished by using an end plug mount which moves on lubricated sliding guide surfaces. Because of the industrial setting in which such molds are

5 operated, the lubricated surfaces become contaminated and wear of the bottom end plug mount sliding surfaces occurs. In as few as 10 to 20 thousand mold cycles, the bottom end plug mount sliding surfaces can wear enough that the bottom end plug does not precisely fit in the mold forming position with resultant mold part lines being created in the bottom of the blow-molded product. Even if the sliding surfaces are protected by seals and/or protective boots, unacceptable
10 wear occurs after 40 to 60 thousand cycles.

When the above described wear problem occurs, the bottom end plug, the mounting block and/or the upper and lower mold halves must be refurbished by the addition of any metal worn away and then refinishing to their original tolerances. Because refurbishment is extremely expensive, in many instances it is more cost-effective to simply replace the upper and lower mold
15 halves along with the bottom end plug.

Thus, it is desirable to provide a mold guide structure which will precisely and accurately position moveable portions of a mold in the mold forming position and at the same time allow it to easily move into and out of the mold forming position through a large number of operating cycles.

20 SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide a guide mechanism to precisely position a moveable mold part such as a bottom end plug in its mold forming position with such precision that little or no sliding contact occurs between mold parts.

It is a further object of the present invention to provide a bearing supported mount with
25 preloaded bearings to precisely position a moveable mold part to avoid sliding contact.

It is a still further object of the present invention to provide a bottom end plug guide mechanism with an operating life of greater than 1,000,000 cycles.

The above and other objects are achieved in the present invention by providing a guide structure for at least one movable mold part in which the guide structure has first and second structures. One of the structures is fixed to a movable mold part and the other structure is fixed to another mold part. The structures are arranged such that one of the structures sandwiches at least a portion of the other structure and a plurality of bearings are located between the sandwiched surfaces. The structures are further arranged such that one of the structures applies a preload pressure to the bearings in a direction normal to the mold movement direction. As a result, due to the bearing preload, the movable mold part is precisely located in position with respect to the remaining mold portions during each and every cycle. The bearings minimize wear between the first and second structure surfaces allowing a 10 to 100-fold or greater increase in the number of mold cycles without need for refurbishment.

In preferred embodiments, a mold having upper and lower halves operates in conjunction with a bottom end plug mounted on a guide structure, as discussed above. The guide structure rigidly mounts the bottom end plug for movement toward and away from the lower mold half under the influence of a cam which is a portion of the upper mold half. Thus, as the upper mold is lowered into position, the cam pushes the bottom end plug in the mold movement direction until it is precisely located in the aperture between the upper and lower mold halves. In a further preferred embodiment, where removal of the molded product is hindered by the upper portion of the bottom end plug, a split bottom end plug may be used in which the upper and lower portions of the plug are mounted respectively to the upper and lower mold halves, each by the inventive guide structure.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objects will be more clearly appreciated by reference to the Figures appended hereto wherein:

Figure 1 is a side view partially in section of a mold for forming molded products in accordance with the present invention with the mold in the open position;

Figure 2 is a side view partially in section of the mold shown in Figure 1, but in the closed, mold forming position;

Figure 3 is a side view partially in section of the guide structure portion of the mold shown in Figure 2;

Figure 4 is a top view of the upper bearing cage shown in Figure 3;

Figure 5 is a side view of the upper bearing cage shown in Figure 3;

5 Figure 6 is a top view of the lower bearing cage shown in Figure 3;

Figure 7 is a side view of the lower bearing cage shown in Figure 3;

Figure 8 is a perspective view of the bearing preload mechanism shown in Figure 3; and

Figure 9 is a side view partially in section of a split bottom plug.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

10 Similar components will be identified by similar reference numbers throughout the separate views.

Figures 1 and 2 illustrate a mold for forming injection blow molded products in accordance with the present invention. However, the present invention is not limited to injection blow molding molds and could also be advantageously utilized for any other molded product.

15 The primary portions of the mold as shown in Figures 1 through 3 are the guide mechanism 10, the bottom end plug 12, the upper mold half 14 and the lower mold half 16. Although the illustrated embodiment shows the lower mold half 16 fixed and the upper mold half 14 vertically movable into a mold forming position shown in Figure 2 and out of a mold forming position in Figure 1, the lower mold half could just as easily be movable with the upper mold half fixed. In
20 fact, both upper and lower mold halves could also be movable, although this would add undue complexity to the molding system.

It is noted that, in conjunction with the movable upper mold half 14 as illustrated, a cam roller 18 is provided which contacts cam surface 20 forcing bottom end plug 12 into the mold forming position shown in Figure 2. While Figures 1 and 2 illustrate that cam surface 20 may be
25 planar, in the Figure 3 detailed view of the guide mechanism 10, the cam surface 20a is shown as having a curved profile. This curved profile will vary the speed at which the bottom end plug moves into the mold forming position shown in Figure 2 with respect to the upper and lower mold halves 14 and 16, respectively.

Guide mechanism 10 is comprised of first structure 22 which, in a preferred embodiment, is fixedly connected to the lower mold half 16. Sandwiching first structure 22 is a second structure comprised of end plug mount 24 and pressure plate 26 joined by bolt 42. Separating first structure 22 and pressure plate 26 are a plurality of roller bearings 28 located in lower roller bearing cage 30 (also seen in Figures 6 & 7). Separating the first structure 22 from end plug mount 24 are a plurality of roller bearings 32 and located in upper roller bearing cage 34 (seen in Figures 4 & 5).

Also located in upper roller bearing cage 34 are at least two guide balls 36. These guide balls fit into a guide ball race 38 machined into the upper surface of first structure 22 and a corresponding guide ball race 40 machined into the lower surface of end plug mount 24. It can be seen that while roller bearings 32 separate first structure 22 from end plug mount 24, the guide balls 36 ensure that relative movement of the end plug mount 24 and thus bottom end plug 12 is along a desired mold movement path into a mold forming position shown in Figure 2 and out of a mold forming position shown in Figure 1.

Although the mold movement path in preferred embodiments is a linear mold movement direction, the path in other embodiments could be curved should a changing vertical position or orientation of the bottom end plug 12 be desirable. In the event a curved path was desirable, the guide ball races 38 and 40 would be similarly curved. Additionally, the lower surface of end plug mount 24 and upper surface of first structure 22 would also have to be curved to facilitate relative movement of the roller bearings 28 therebetween. Similarly, the lower surface of first structure 22 and upper surface of pressure plate 26 would also have to be curved to facilitate the desired curved motion and to permit movement of the roller bearings 28 therebetween.

An important aspect of the present invention is the fact that the elements are arranged such that the roller bearings (and possibly guide balls) are preloaded in order to eliminate any tolerances or tolerance build-up so as to achieve precise location of the end plug 12 in the mold forming position. In the embodiment shown in Figures 1-3, this preloading is accomplished by the bolt 42, shown as a ~~cap screw headed~~ ^{Shoulder} bolt, which is threaded into swivel nut 44 which in a preferred embodiment has a hemispherical head which cooperates with a hemispherical aperture in pressure plate 26. Because of the cooperating hemispherical shapes, the pressure applied by

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the swivel nut 44 to the pressure plate is uniform over the pressure plate and thus the preload compression on the plurality of lower roller bearings 28, as well as upper roller bearings 32, can be relatively uniform.

5 The inclusion of a strong spring under the head of bolt 42, such as belleville springs 46, serve to provide the desired preloading to the bearings by sandwiching the first structure between the pressure plate 26 and end plug mount 24. In a preferred embodiment, a preload on the order of 80 lbs. has been found appropriate. However, depending upon the bearings and the components, different preload pressures could be used.

10 ~~As previously discussed, the cooperation between cam roller 18 and cam surface 20 (or curved cam surface 20a) moves the end plug mount 24, and bottom end plug 12 mounted thereon, into the mold forming position (wherein the parts of the mold are closed actually forming a mold). The guide mechanism 10 also includes a return spring 46 which serves to bias the end plug mount 24 to the left as shown in Figures 1-3. The operation of the cam roller against the cam surface 20 (or 20a) when the upper mold half 14 descends toward the mold forming position (shown in Figure 2) overcomes the bias of return spring 46, allowing the bottom end plug 12 to be moved into proper position relative the upper and lower mold halves. When the pressure of cam roller 18 against the cam surface 20 (or 20a) is withdrawn as the upper mold half 14 is moved away from the mold forming position, the return spring withdraws the bottom end plug 12 from its mold forming position to the mold open position.~~

15 ~~20 While the return spring biases the bottom end plug away from the mold forming position in this embodiment, it will be readily apparent that one of ordinary skill in the art could utilize a spring forcing the bottom end plug into the mold forming position and use a cam roller and a cam surface to move the bottom end plug away from the mold forming position during movement of the upper mold half. Moreover, it will also be apparent that structures other than springs and/or~~
 25 ~~cam rollers and cam surfaces could be used, such as pneumatic or hydraulic actuators, electric motors, etc.~~

Given that pressure plate 26 and end plug mount 24 are both connected together by bolt 42 and biased toward one another by belleville springs 46, they clearly move together in contact

with the bearings and the cooperating bearing surfaces on first structure 22. It would be desirable to prevent dirt and other contaminants from contacting the bearings or the bearing surfaces.

The details of the upper bearing cage 34 can be seen in Figures 4 and 5. While the upper bearing cage 34 maintains the relative position of the roller bearings 32 and the guide balls 36, it also serves to mount a peripheral o-ring seal 50 which effectively seals the space between the lower surface of end plug mount 24 and the flat upper surface of fixed structure 22. Either a single seal could be used or in the preferred embodiment separate seals on the top and bottom of the cage 34 are provided. Guide race plugs 52, sized to fit the space between the guide ball races 38 and 40, also have smaller o-ring seals 54 which serve to seal the space in front of and behind the guide balls 36.

In a manner similar to upper roller bearing cage 34, lower cage 30 is shown in detail in Figures 6 and 7. The lower cage 30 includes a peripheral o-ring seal 56 (preferably on the top and bottom of the cage) which effectively seals the upper surface of pressure plate 26 with the lower surface of the first structure 22. While the preferred embodiment illustrates guide balls 36 being located in guide ball races 38 & 40 formed in the end plug mount 24 and in the first structure 22, respectively, such guide balls could also be located in races created in the lower surface of first structure 22 and the upper surface of pressure plate 26. In fact, guide balls could be included in both surfaces if a very high degree of accuracy is desired.

Figure 9 illustrates the embodiment in which the bottom end plug 12 is split into an upper portion 12a and a lower portion 12b, each of which are movable with respect to the other and with respect to their corresponding upper and lower mold halves 14 and 16, respectively. Each end plug portion has an associated guide mechanism similar to the guide mechanism illustrated in Figures 1-3. The lower portion 12b has a tab 58 which fits into receptacle 60 in the upper portion 12a as the mold is closed. The receptacle and/or the tab can include a bushing to reduce friction forces and wear when the tab moves into the receptacle. The tab engages the receptacle as the portions come together but before the cam roller 18 begins to press against the cam surface 20 (or 20a). As a result, when the cam roller 18 does contact the cam surface 20 (or 20a), it moves both the upper portion 12a and the lower portion 12b move together in the mold movement direction into position in the mold. In a preferred embodiment, both the tab 58 and the receptacle

60 are spring biased towards the position shown, such that if misalignment does occur and the tab 58 contacts the side of receptacle 60 during movement of the upper and lower portions toward each other, the tab and receptacle will retract into the upper and lower portions, respectively, without damaging either structure.

5 The use of a split bottom plug is particularly advantageous where the bottom of a blow molded article is highly concave and the bottom end plug protrudes significantly into the molded article. When the single bottom end plug is withdrawn from the mold forming position and the mold has been opened, the bottom of the blow molded product upon removal may contact the protruding portion of the bottom end plug.

10 In view of the above description, many variations and modifications of the present invention will be apparent to those of ordinary skill in the mold art. For example, many different types of bearings and/or bearing races could be used depending upon different design features. The movement of the end plug into and out of the mold forming position could be controlled independently of or in synchronization with the movement of the other mold parts. Thus the
15 present invention is limited only by the scope of the claims appended hereto.